Ecological Approach to Infrastructure Development: Project-level (Fine-scale) Ecological Significance and Wetland Mitigation and Restoration Data Layers

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EAST-WEST GATEWAY
Council of Governments

Missouri Resource Assessment Partnership Contact:

David Diamond
Missouri Resource Assessment Partnership
School of Natural Resources
University of Missouri
4200 New Haven Road
Columbia, MO 65201
(573)876-1862
diamondd@missouri.edu

East-West Gateway Contact:
Mary Grace Lewandowski
Transportation Planner
East-West Gateway Council of Governments
One Memorial Drive, Suite 1600
St. Louis, MO 63102

Primary Contributors from the Missouri Resource Assessment Partnership:

Clayton Blodgett
David Diamond
Lee Elliott
Phillip Hanberry
Ronnie Lea
Kimberly Traxler Mabrey
Diane True

Primary contributors from the East-West Gateway Council of Governments

Jennifer Reiman
Gary Mook
Steve Nagle
Caroline Twenter
David Wilson

The East-West Gateway Council of Governments serves an eight county region, five in Missouri and three in Illinois, and has an overall mission of helping the region to "offer its residents an unexcelled quality of life." In FY2010, the Missouri Resource Assessment Partnership produced a regional ecological significance datalayer to help facilitated planning efforts (Figure 1).

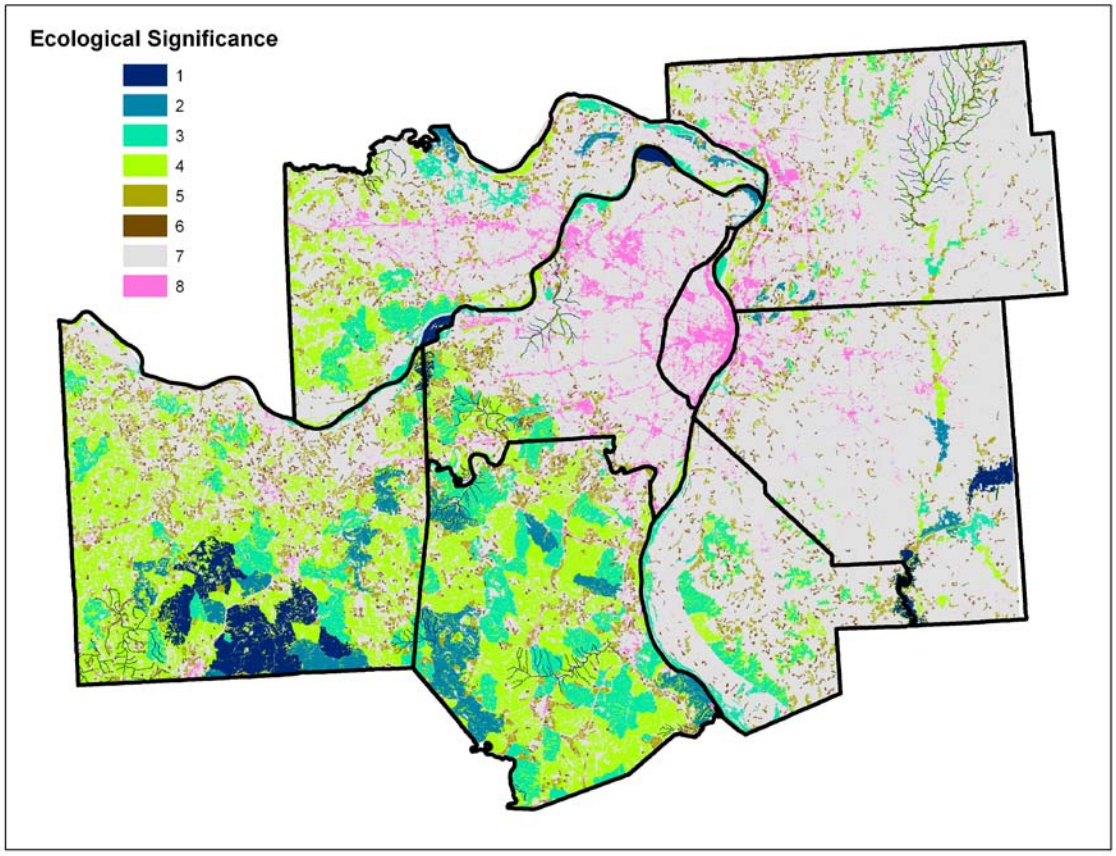

Figure 1. Regional ecological significance (1 is high, 8 is low) for the East-West Gateway planning region.

In FY2011, our goals were to (1) make final revisions to this datalayer and provide metadata for delivery, (2) work with East-West Gateway staff to explore ways to integrate this information for regional and project-level planning in concert with workers at LEAM (land use evaluation and impact assessment model), (3) prepare a finer resolution, project-level ecological significance datalayer for use on a project by project basis, and (4) prepare and deliver easy to understand interpretive materials and participate in meetings with partners as needed. To satisfy goal #3, we worked with East-West Gateway staff and partners to add on the task of developing information specific to wetlands, including spatially-specific wetland mitigation and wetland restoration data.

To date, partner meetings have been held, metadata have been delivered with the regional ecological significance GIS data, and materials were provided for integration into a LEAM urban risk model. In addition, East-West Gateway staff developed a method for using ecological significance ranks for scoring individual projects that involved use of thresholds (e.g. one pixel with a very high ecological significance value influences the overall project score) as well as average significance values within 0.25 and 1 mile buffers of proposed projects.

The remainder of this document relates to the development of a project-level ecological significance datalayer, and of wetlands mitigation and restoration data. A separate document, *"Current Mapped Vegetation of the East-West Gateway Region Interpretive Guide,"* was prepared to either stand alone or accompany a GIS datalayer of current vegetation.

Development of Project-level Ecological Significance Datalayer

The regional ecological significance datalayer developed in 2010 emphasized the importance of functional landscape patches of semi-natural and natural vegetation, and the results are most appropriate for use when setting priorities on a regional scale (Figure 1). Many project-based decisions must be made at a finer scale of resolution. We developed a project-level ecological significance datalayer to address this need.

The spatial grain size of the project-level significance datalayer is greater than that of the regional significance data. Scores are applied to all mapped current vegetation types (community types) to define project-level significance, whereas regional significance was mapped based on patches of natural and semi-natural vegetation made up of several or many individual mapped vegetation types that were combined or collapsed together (Figure 2). Nonetheless, many of the same input data layers generated for regional ecological significance evaluation were used to generate project-level significance, including current land cover and community importance ranking (Table 1), rare species locations and status, public lands, and the final results of the regional analysis itself. Data development details are found in *"Ecological Approach to Infrastructure Development for the East-West Gateway, Final Report,"* available from the East-West Gateway or from the MoRAP website (http://www.cerc.usgs.gov/morap/Assets/UploadedFiles/Projects/EastWestGateway/Regional%20Ecological%20Significance%20Data%20Layer%20Report.pdf).

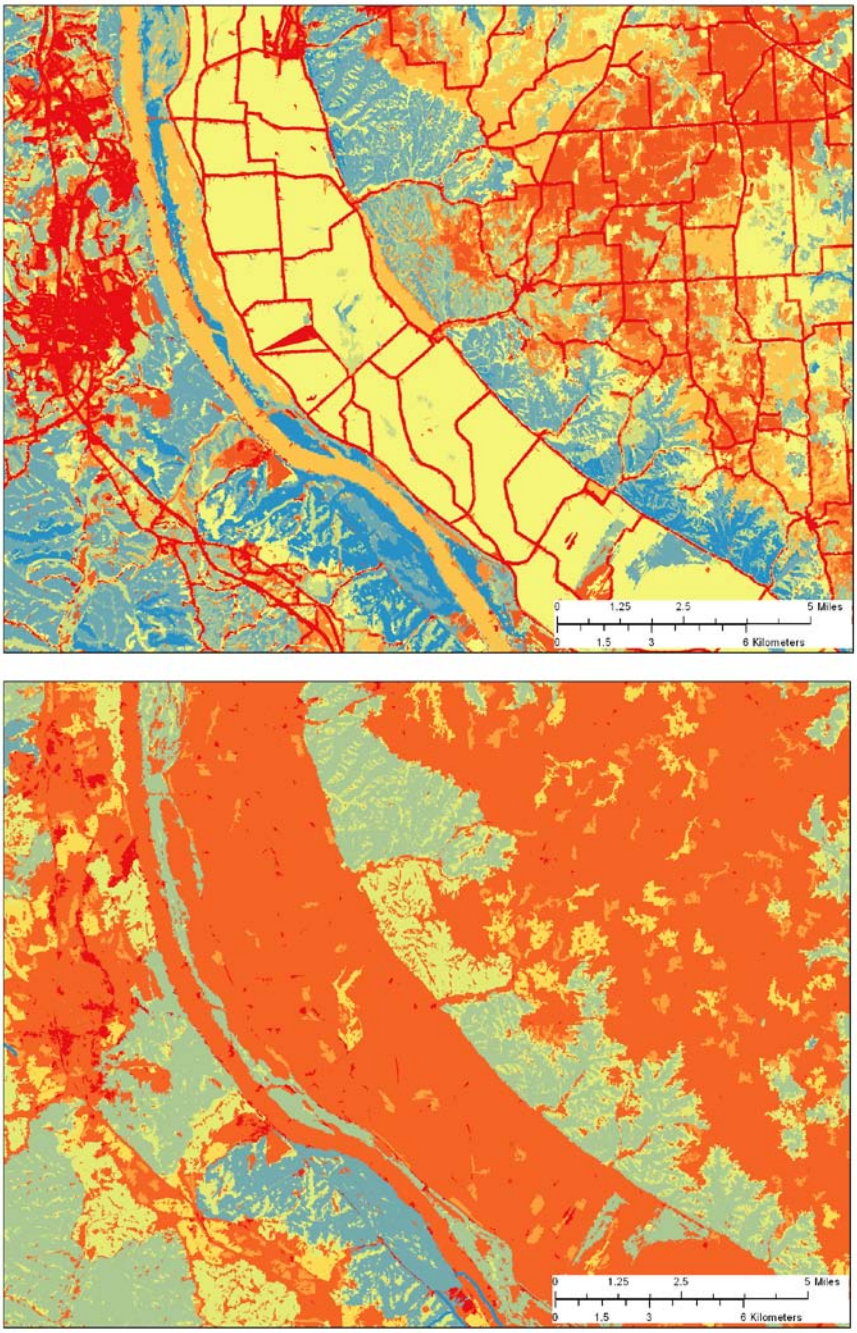

Figure 2. Project-level ecological significance (top) versus regional ecological significance (bottom) for an area around the Middle Mississippi National Wildlife Refuge in Jefferson County, MO, and Monroe County, IL. Red and orange represent lower significance whereas blue represents higher significance. Scores for project-level significance are applied to current vegetation patches, whereas scores for regional-level significance are applied to combined (collapsed) patches of all natural and semi-natural vegetation.

Table 1. Current vegetation, community importance rank, and area of mapped vegetation for the East-West Gateway planning region. Community importance ranks are based on professional judgment and on ranks applied by NatureServe to community elements within the National Vegetation Classification (http://www.natureserve.org/explorer/classeco.htm).

Name	Importance Rank	Area (ha)
Barren or Sparsely Vegetated	1	3,635
Bottomland Forest: Mixed Bottomland Hardwood Forest	9	7,135
Bottomland Forest: Pin Oak/Bur Oak-Swamp White Oak/Pecan Forest	9	5,504
Bottomland Forest: Sycamore, Cottonwood, Elm, Ash Hackberry Riverfront Forest	9	7,615
Bottomland Forest: White Oak/Red Oak-Dogwood/Sycamore Forest	9	1,319
Bottomland: Disturbance Grassland	5	57,126
Bottomland: Herbaceous-dominated Wetlands	9	13,620
Bottomland: Successional Deciduous Woodland and Shrubland	5	1,911
Bottomland: Successional Eastern Redcedar Sparse Woodland and Shrubland	5	6,724
Bottomland: Successional Eastern Redcedar Woodland	5	1,877
Bottomland: Successional Eastern Redcedar-Deciduous Mixed Woodland and Forest	5	3,044
Bottomland: Successional or Disturbance Woodland and Forest	5	618
Bottomland: Wooded Wetland	9	30,046
Central Dissected Till Plains: Loess and Till Upland Bur Oak/Post Oak Upland Woodland	6	5
Central Dissected Till Plains: Loess or Till Upland Bur Oak/Post Oak-Bluestem Prairie and Savanna (wooded)	6	1,461
Cropland	2	267,685
Cultural/Disturbance Upland Sandstone Grassland	3	101
Cultural/Disturbance: Upland Limestone/Dolomite and Chert Grassland	3	44,937
Cultural/Disturbance: Upland Loess and Till Grassland	3	114,151
Disturbance or Successional Upland Grassland	3	11,282

Name	Importance Rank	Area (ha)
Herbaceous-dominated Wetlands (non-riverine)	7	4,671
Illinois Hill Prairie or Glade (grassy)	9	2,227
Illinois Hill Prairie or Glade (wooded)	9	4,259
Illinois Loess and Till: Mesic Backslope Red Oak/Basswood-Sugar Maple Forest	9	665
Illinois Loess and Till: Typic Backslope White Oak/Red Oak-Hickory Woodland and Forest	8	4,744
Illinois Loess and Till: White Oak/Red Oak-Hickory Woodland and Forest	6	16,166
Illinois Pin Oak/Post Oak-Hickory Flatwood Forest	6	48
Illinois Post Oak-Bluestem Prairie and Savanna (wooded)	6	246
Mississippi River: Mesic Bottomland Prairie	9	84
Mississippi River: Wet Bottomland Prairie	9	130
Mississippi River: Wet-mesic Bottomland Prairie	9	1,115
Open Water	not ranked	25,434
Ozark Highlands: Chert Backslope White Oak/Black Oak-Dogwood Woodland and Forest	8	59,712
Ozark Highlands: Chert Upland Mixed Oak Woodlands	6	4,843
Ozark Highlands: Chert Upland Post Oak-Bluestem Prairie and Savanna (wooded)	6	8,391
Ozark Highlands: Limestone/Dolomite Backslope White Oak/Chinquapin Oak-Dogwood Woodland and Forest	8	12,777
Ozark Highlands: Limestone/Dolomite Cliff/Talus Complex	8	710
Ozark Highlands: Limestone/Dolomite Upland Chinquapin Oak-Post Oak/White Oak Woodland	6	7,986
Ozark Highlands: Limestone/Dolomite Upland Glade/Chinquapin Oak Woodland Complex (deciduous woods)	9	10,887
Ozark Highlands: Limestone/Dolomite Upland Glade/Chinquapin Oak Woodland Complex (grassy)	9	15,269
Ozark Highlands: Limestone/Dolomite Upland Glade/Chinquapin Oak Woodland Complex (juniper or mixed woods)	9	32,864

Name	Importance Rank	Area (ha)
Ozark Highlands: Loess and Till Backslope Grassland, Sparse Woodland, and Shrubland	8	718
Ozark Highlands: Loess and Till Backslope White Oak/Black Oak-Hickory Woodland and Forest	8	12,011
Ozark Highlands: Loess and Till Upland Post Oak/White Oak-Black Oak Woodland	6	16,744
Ozark Highlands: Mesic Backslope and Valley Red Oak/White Oak-Sugar Maple/Basswood Forest	9	8,010
Ozark Highlands: Sandstone Backslope Red Oak/White Oak-Sugar Maple Forest	8	8,966
Ozark Highlands: Sandstone Upland Glade/Post Oak Woodland Complex (deciduous woods)	9	215
Ozark Highlands: Sandstone Upland Glade/Post Oak Woodland Complex (grassy)	9	1,890
Ozark Highlands: Sandstone Upland Glade/Post Oak Woodland Complex (juniper or mixed woods)	9	2,381
Ozark Highlands: Sandstone Upland Post Oak/Black Oak-Blackjack Oak/Scarlet Oak Woodland	6	5,595
Ozark Highlands: Upland Dry Post Oak-Bluestem Flatwoods (wooded)	6	15,889
Riverine and Bottomland Unvegetated Soil, Mud, Sand, or Gravel	5	927
Successional Upland Deciduous Sparse Woodland and Shrubland	4	2,902
Successional Upland Eastern Redcedar Evergreen Sparse Woodland and Shrubland	4	38,325
Successional Upland Eastern Redcedar Evergreen Woodland and Forest	4	6,201
Successional Upland Eastern Redcedar-Deciduous Mixed Woodland and Forest	4	16,309
Urban High Intensity	1	39,466
Urban Low Intensity	1	205,831
Woody-dominated Wetland (non-riverine)	7	1,618

The modeling algorithm applied to current vegetation patches to score project-level significance considered both community and species significance as well as landscape context and viability. Because the scores were assigned to current vegetation patches rather than patches of natural and semi-natural vegetation comprised of a number of different community types, less emphasis was placed on overall landscape context and viability and more on current condition versus the regional ecological significance analysis. The following variables were used for scoring:

Community Importance (from 1 to 9, see Table 1)
Regional Significance (from 1 to 8 based on earlier analyses, see Figure 1)
Federal Rare Species (+1 to score if a rare species record occurs within the patch)
Element Occurrence Record (+1 for any patch with an EOR tracked by MO or IL)
Public Lands (+2 if within 50 m of public lands; +1 if within 1 km)
Roads (-5 if within a road buffer, defined as 50 m on either side of road center lines)

The ranking results assigned values from -3 to 21 to current vegetation patches. Based on conversations with East-West Gateway staff and on viewing results on-screen, we collapsed the original 24 classes into 9 using professional judgment (Figure 3). Scores of 1 or 2 (502,915 ha, 43.6%) generally represent cultural grassland, cropland, urban land, or natural vegetation within an urban context with low ecological integrity. Scores of 7 or higher (156,763 ha, 20.8%) or higher generally represent natural vegetation that appears ecologically viable in terms of the potential for conservation.

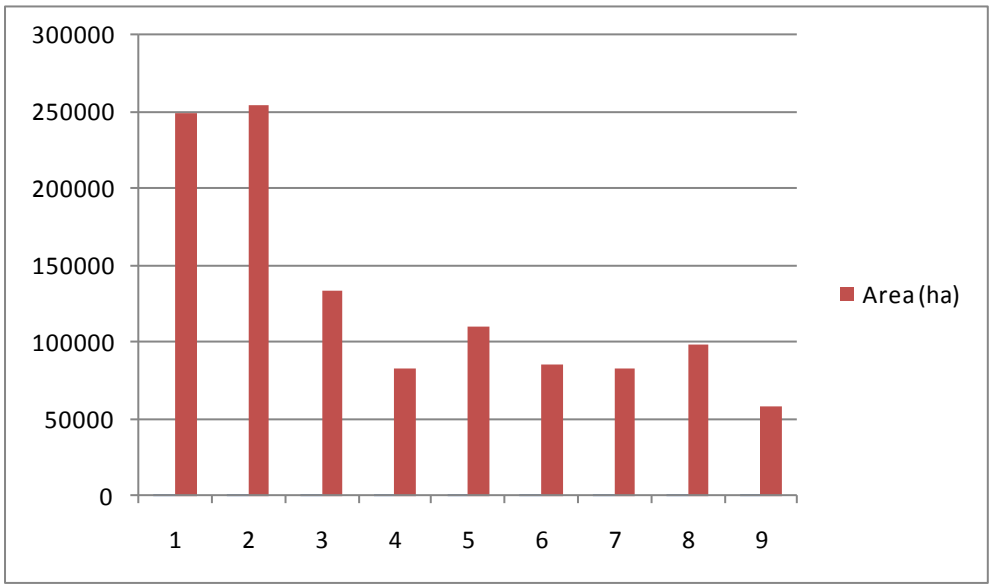

Figure 3. Distribution of project-level significance scores from 1 (lowest) to 9 (highest).

Development of Wetlands Mitigation and Restoration Data

Activities that disturb wetlands, streams, and other waters are regulated, and authorized impacts must be permitted under Section 404 of the Clean Water Act. Permits require compensatory mitigation for authorized impacts. Extant wetlands must be conserved, or non-wetland areas must be restored, as part of the permitting process. For this reason, we placed special emphasis on evaluation of the location and ecological significance of wetlands in the East-West Gateway region.

One important basis for ranking was the assignment of community importance ranks for mapped vegetation types that occur within bottomland soils (Table 2). Bottomland soil polygons were taken from digital county soil surveys (http://soils.usda.gov/survey/geography/ssurgo/) and were intersected with image objects that were assigned mapped vegetation types. Spatial inconsistencies between soil polygons and image objects, which may straddle bottomland and adjacent upland soils, resulted in the inclusion of small areas of upland types within the bottomland mask. Since neither soils nor image objects are absolutely spatially correct, we simply accept these small inconsistencies. Upland types are generally given lower community important ranks, except for those that occur on mesic slopes and toe slopes, which may be closely associated, or continuous, with bottomland types.

Table 2. Current vegetation, community importance rank, and area of mapped vegetation over bottomland soils for the East-West Gateway planning region. Bottomland soils are defined by digital county soils data, whereas current vegetation was assigned to image objects, which results in some spatial inconsistency and the inclusion of small amounts of upland types in the data. Community importance ranks are based on professional judgment and on ranks applied by NatureServe to community elements within the National Vegetation Classification (http://www.natureserve.org/explorer/classeco.htm).

Mapped Vegetation Name	Area (ha)	Importance Rank
Barren or Sparsely Vegetated	97	2
Bottomland Forest: Mixed Bottomland Hardwood Forest	4,704	6
Bottomland Forest: Pin Oak/Bur Oak-Swamp White Oak/Pecan Forest	5,005	6
Bottomland Forest: Sycamore, Cottonwood, Elm, Ash Hackberry Riverfront Forest	7,046	6
Bottomland Forest: White Oak/Red Oak-Dogwood/Sycamore Forest	1,130	6
Bottomland: Disturbance Grassland	50,404	5
Bottomland: Herbaceous-dominated Wetlands	12,948	7
Bottomland: Successional Deciduous Woodland and Shrubland	1,761	5
Bottomland: Successional Eastern Redcedar Sparse Woodland and Shrubland	5,828	5
Bottomland: Successional Eastern Redcedar Woodland	1,687	5

Mapped Vegetation Name	Area (ha)	Importance Rank
Bottomland: Successional Eastern Redcedar-Deciduous Mixed Woodland and Forest	2,724	5
Bottomland: Successional or Disturbance Woodland and Forest	566	5
Bottomland: Wooded Wetland	28,896	7
Central Dissected Till Plains: Loess or Till Upland Bur Oak/Post Oak-Bluestem Prairie and Savanna (wooded)	20	3
Cropland	102,407	2
Cultural/Disturbance Upland Sandstone Grassland	2	3
Cultural/Disturbance: Upland Limestone/Dolomite and Chert Grassland	751	3
Cultural/Disturbance: Upland Loess and Till Grassland	2,238	3
Disturbance or Successional Upland Grassland	1,210	3
Herbaceous-dominated Wetlands (non-riverine)	2,277	7
Illinois Hill Prairie or Glade (grassy)	185	3
Illinois Hill Prairie or Glade (wooded)	253	3
Illinois Loess and Till: Mesic Backslope Red Oak/Basswood-Sugar Maple Forest	20	4
Illinois Loess and Till: Typic Backslope White Oak/Red Oak-Hickory Woodland and Forest	146	4
Illinois Loess and Till: White Oak/Red Oak-Hickory Woodland and Forest	970	3
Illinois Pin Oak/Post Oak-Hickory Flatwood Forest	3	4
Illinois Post Oak-Bluestem Prairie and Savanna (wooded)	1	3
Mississippi River: Mesic Bottomland Prairie	84	7
Mississippi River: Wet Bottomland Prairie	126	7
Mississippi River: Wet-mesic Bottomland Prairie	1,113	7
Open Water	7,104	not ranked
Ozark Highlands: Chert Backslope White Oak/Black Oak-Dogwood Woodland and Forest	765	4
Ozark Highlands: Chert Upland Mixed Oak Woodlands	13	3
Ozark Highlands: Chert Upland Post Oak-Bluestem Prairie and Savanna (wooded)	96	3
Ozark Highlands: Limestone/Dolomite Backslope White Oak/Chinquapin Oak-Dogwood Woodland and Forest	201	4
Ozark Highlands: Limestone/Dolomite Cliff/Talus Complex	43	3
Ozark Highlands: Limestone/Dolomite Upland Chinquapin Oak-Post Oak/White Oak Woodland	86	3
Ozark Highlands: Limestone/Dolomite Upland Glade/Chinquapin Oak Woodland Complex (deciduous woods)	234	3
Ozark Highlands: Limestone/Dolomite Upland Glade/Chinquapin Oak Woodland Complex (grassy)	343	3

Mapped Vegetation Name	Area (ha)	Importance Rank
Ozark Highlands: Limestone/Dolomite Upland Glade/Chinquapin Oak Woodland Complex (juniper or mixed woods)	477	3
Ozark Highlands: Loess and Till Backslope Grassland, Sparse Woodland, and Shrubland	14	4
Ozark Highlands: Loess and Till Backslope White Oak/Black Oak-Hickory Woodland and Forest	200	4
Ozark Highlands: Loess and Till Upland Post Oak/White Oak-Black Oak Woodland	157	3
Ozark Highlands: Mesic Backslope and Valley Red Oak/White Oak-Sugar Maple/Basswood Forest	128	4
Ozark Highlands: Sandstone Backslope Red Oak/White Oak-Sugar Maple Forest	147	4
Ozark Highlands: Sandstone Upland Glade/Post Oak Woodland Complex (deciduous woods)	10	3
Ozark Highlands: Sandstone Upland Glade/Post Oak Woodland Complex (grassy)	48	3
Ozark Highlands: Sandstone Upland Glade/Post Oak Woodland Complex (juniper or mixed woods)	54	3
Ozark Highlands: Sandstone Upland Post Oak/Black Oak-Blackjack Oak/Scarlet Oak Woodland	22	3
Ozark Highlands: Upland Dry Post Oak-Bluestem Flatwoods (wooded)	94	3
Riverine and Bottomland Unvegetated Soil, Mud, Sand, or Gravel	889	5
Successional Upland Deciduous Sparse Woodland and Shrubland	161	3
Successional Upland Eastern Redcedar Evergreen Sparse Woodland and Shrubland	1,400	3
Successional Upland Eastern Redcedar Evergreen Woodland and Forest	282	3
Successional Upland Eastern Redcedar-Deciduous Mixed Woodland and Forest	972	3
Urban High Intensity	9,084	1
Urban Low Intensity	35,144	1
Woody-dominated Wetland (non-riverine)	491	7

Wetland Mitigation versus Wetland Restoration: Definitions - We ranked all areas over bottomland soils as having either potential wetland mitigation value or potential wetland restoration value. Cropland, barren or sparsely vegetation land, and open water were ranked in terms of potential for restoration, and all other extant vegetation types were ranked in terms of potential for mitigation. In this regard, the terminology herein may not correspond with definitions used within regulatory contexts.

Wetland Mitigation Ranking – Wetland mitigation ranks are based on community significance and landscape context, which relates to viability. The scores are as follows:

Wetland Community Importance Rank (from 1 to 7, Table 2)
Project-level Significance (+1 if ranked 9 within the project-level significance datalayer)
Public Lands (+2 if <50 m from public lands; +1 if <100 m but >50 m from public lands)
Water (+1 if touching water)
Roads and Urban land cover (-1 if touching a road buffer or urban land cover)

Scores for this datalayer ranged from 2 to 11 (Figures 4, 5). Vegetation patches scored as 2 or 3 are generally small fragments of upland types mapped within bottomland soil polygons, and these make up 8,668 ha (6.2%) of the wetland mitigation areas. Vegetation patches scored as 4 or 5 are bottomland disturbance or successional types, and account for 60,103 ha (43.1%) of mitigation areas. Places ranked as 10 or 11 comprise 11,034 ha (7.9%) of mitigation areas. These include existing wooded or herbaceous wetlands, and are most valuable and best suited to wetland mitigation.

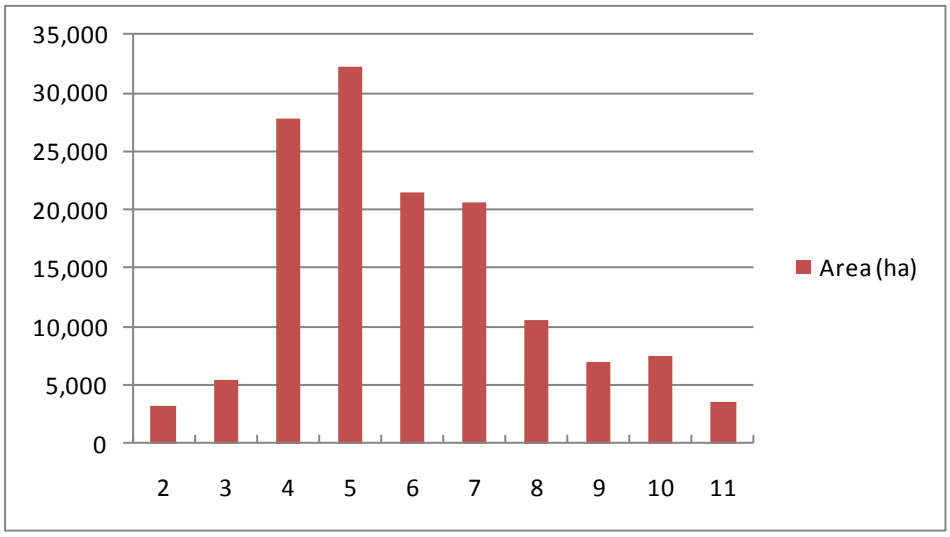

Figure 4. Distribution of wetland mitigation scores from lowest (2) to highest (11). All mitigation areas consist of extant vegetation patches within bottomland soil polygons.

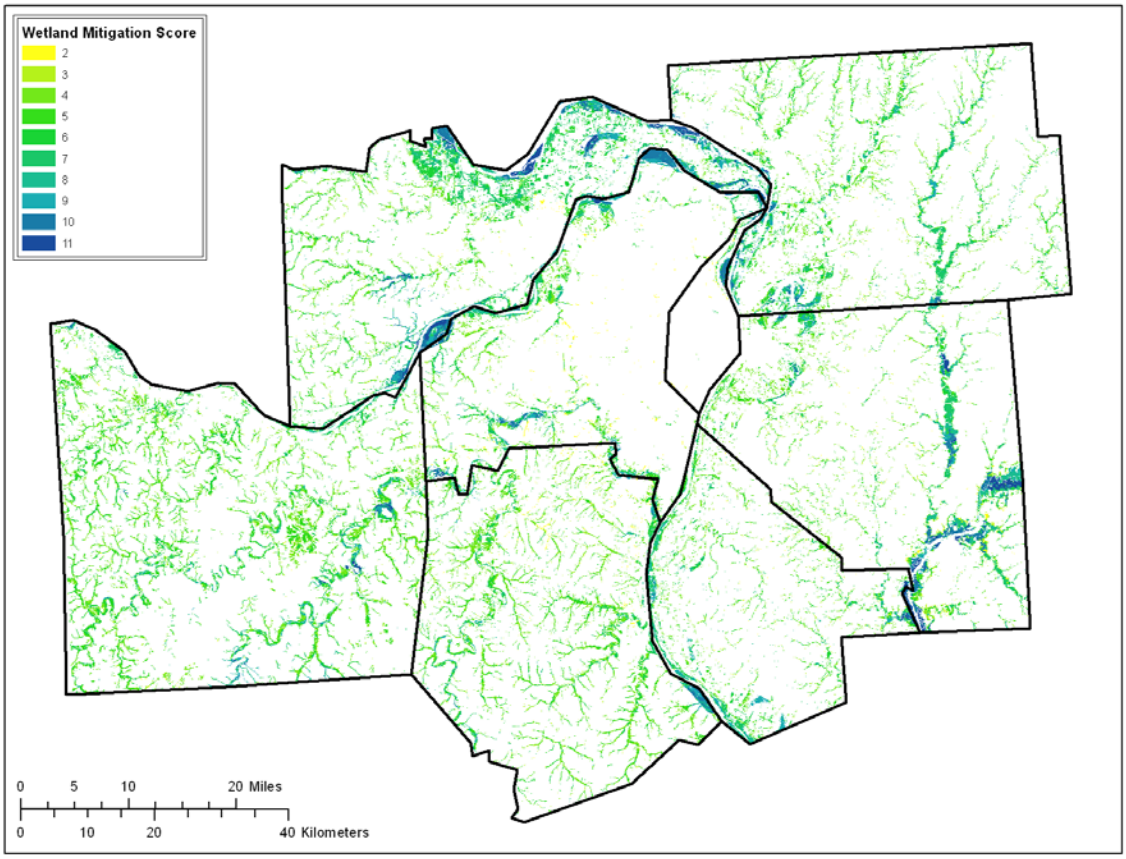

Figure 5. Wetland mitigation ranking for the East-West Gateway region. All mitigation areas consist of extant vegetation patches within bottomland soil polygons.

Wetland Restoration Ranking – Wetland restoration ranks were assigned only to cropland and barren or sparsely vegetation land, with cropland making up 102,407 ha of the area (99.9%), and barren making up only 97 ha. The scoring is based on landscape context as follows:

Public Lands (+2 if <100 m from public lands; +1 if <500 m but >100 m from public lands)
Proximity to Extant Wetlands (+2 if <100 m from extant wetlands; +1 if < 500 m but >100 m)
Proximity to Water (+1 if touching water)
Proximity to Roads and Urban Areas (-1 if touching a road buffer or within 100 m of urban)

Scores ranged from -1 to 5 (Figures 6, 7). The majority of potential restoration areas, 66,230 ha (64.6% of the total area), are scored 1 or 2, and are either close to public lands or close to existing wetlands, but not both. Places scored >3 include 11,474 ha (11.2% of

the area), and are positioned close to two or sometimes three desirable landscape attributes, including existing wetlands, public lands, or water. These areas are most worthy of restoration efforts.

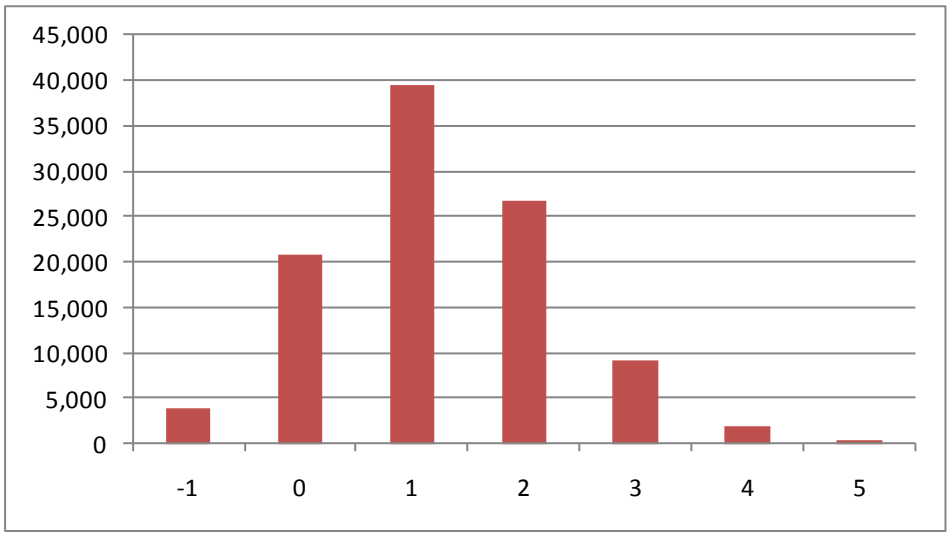

Figure 6. Distribution of wetland restoration scores from lowest (-1) to highest (5). Restoration areas consist almost entirely of cropland, and scores are based on proximity to existing wetlands, public lands, roads, and urban land cover.

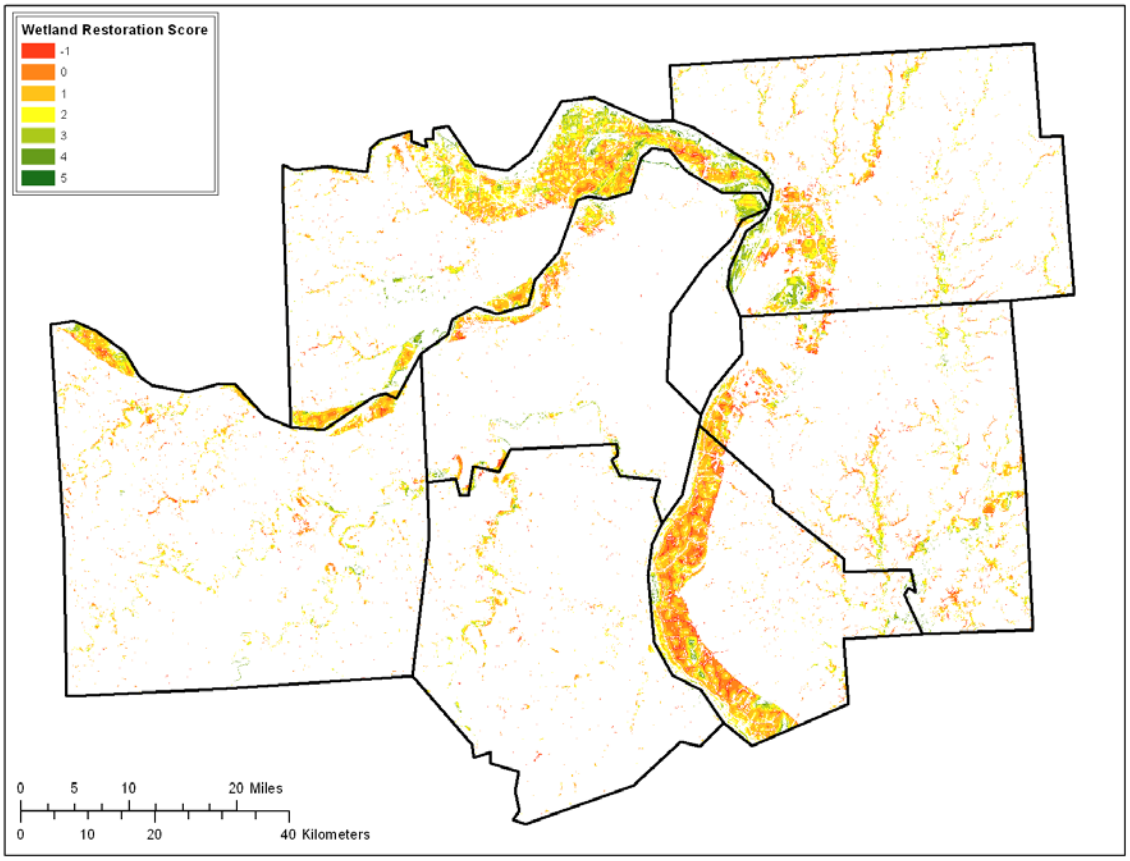

Figure 7. Wetland restoration ranking for the East-West Gateway region. Restoration ranks were applied to cropland and barren land, with cropland making up >99% of the area.

Caveats and Limitations of Wetland Scoring – Lack of information on hydrologic regime, lack of fine-resolution elevation data, and lack of information on vegetation height and density are primary limitations in terms of wetland mapping and, in turn, wetland mitigation and restoration scoring. Extant vegetation may be more or less wet, and croplands more or less suited to restoration, based on hydrology and elevation. Shrub versus marsh wetlands are not perfectly separated based on satellite remote sensing information. Therefore, we did not attempt to map wetlands in terms of water regime, and the data presented here are not suited to identification of jurisdictional wetlands as defined under Section 404 of the Clean Water Act.

Nearly all intermediate sized streams, and most of the smaller streams, have impoundments somewhere within the watershed that impact hydrologic regime. Levees along the Missouri and water control locks and dams along the Mississippi are designed to prevent flooding. Wide bottomlands associated with these big rivers are largely disconnected from the main channel, and wetlands are therefore generally not associated with over-bank flooding. They tend to be shallow depressions that receive run-on during

rainfall events or are deeper ox-bows. Agricultural practices, and in some cases conservation management, also maintain some wetlands. A finer-resolution digital elevation model, coupled with finer-resolution vegetation mapping, would aid in identification of wetland type and in scoring wetland mitigation and restoration potential.